IJAER/March-April-2025/Volume-14/Issue-2 ISSN: 2278-9677

International Journal of Arts & Education Research

(Peer-Reviewed, Open Access, Fully Refereed International Journal) Impact Factor:7.06

RESOURCE EFFICIENCY IN VEGETABLE VERSUS RICE CULTIVATION IN DURG DISTRICT

Praveen Verma

Research Scholar, Bharti Vishwavidyalaya, Durg, Chhattisgarh

Dr. Nina Singh

Bharti Vishwavidyalaya, Durg, Chhattisgarh

Abstract

When it comes to the production of food in a sustainable manner, agricultural resource efficiency is of the utmost importance. This is especially true in areas such as the Durg District in Chhattisgarh, where the cultivation of both rice and vegetables plays an important part in the agrarian economy. The purpose of this study is to compare and contrast the resource efficiency of rice farming and vegetable growing by analysing inputs such as water, fertilisers, labour, and land utilisation. For the purpose of determining the yield per unit of resource, the research make use of actual data collected from local farmers as well as statistical approaches. Based on preliminary data, it has been determined that the cultivation of vegetables exhibits a greater water-use efficiency and profitability per hectare in comparison to rice cultivation, which demands a significant amount of water yet continues to be a staple crop. For the purpose of enhancing both production and environmental sustainability, the study highlights the necessity of governmental interventions that promote efficient irrigation systems and sustainable farming practices within the agricultural sector.

Keywords: *Resource efficiency, rice cultivation, vegetable farming, Durg District, water-use efficiency, sustainable agriculture*

Introduction

A sizeable majority of the population in India relies on agriculture as their primary source of income, making it the most important sector of the Indian economy. Rice and vegetable farming are both essential components of the agricultural landscape of Chhattisgarh, notably in the Durg District. The cultivation of rice, which is a basic food, is vast, while the cultivation of vegetables contributes to the diversity of diets and the economic viability of nations. On the other hand, the ever-increasing demand placed on natural resources like water, land, and fertilisers calls for an analysis of how effectively these resources may be utilised in a variety of agricultural systems. The production of rice, particularly in water-intensive conventional ways, presents issues that are associated with the depletion of groundwater, the heavy dependence on fertiliser, and the destruction of the existing ecosystem. Vegetable growing, on the other hand, is becoming an increasingly feasible option since it often requires less water and offers greater returns per unit of input. By gaining an understanding of the relative resource efficiency of these two agricultural approaches, it is possible to optimise the use of land, lower the prices of inputs, and promote sustainable farming in the region. The purpose of this research is to evaluate the resource efficiency of rice and vegetable farming in the Durg District by analysing important characteristics such as the amount of water used, the amount of labour required, the amount of fertiliser used, and the product yield. The purpose of this research is to give insights that will enable policymakers, farmers, and other agricultural stakeholders to make educated decisions on crop selection and resource management. These insights will be provided by evaluating the advantages and limits of each management system.

Materials and methods

Study area description

In the year 2020, the field experiment was carried out at Mahamara village, which is located in the Durg District of Chhattisgarh located at 21.176384 North and 81.245458 East. The growing season lasted from January to April. With a pH of 5.6 and a soil matter carbon content of 1.8%, the soil at the experimental location had a sandy loam texture, consisting of sixty percent sand, seventeen percent silt, and twenty-three percent clay.

Experimental design and treatments

A randomised block design (RBD) was utilised for the experimental design, which consisted of two replications with plot sizes measuring 2 meters by 4 meters. The cultivation of rice was carried out using two different crop management systems: first, the standard management practices (SMP) with continuous flooding, which is the current recommendation (ICAR, 2006), and second, the System of Rice Intensification (SRI) with alternate wetting and drying (AWD) water management throughout the vegetative stage. Organic manure, which is cow dung that has been entirely digested, was spread throughout the whole main field after it had been puddling (as shown in Figure 1a), levelled and any surplus water had been drained. In order to prevent water seepage and nutrient diffusion between plots, each plot was surrounded by bunds that were fifty centimetres wide, and these bunds were then followed by irrigation canals that were also fifty centimetres wide. A nursery was used to create rice seedlings of the "Mestiso 20" (M20) variety (as shown in Figure 1b). These seedlings were then transplanted into a puddled field by 15 days, with a spacing of 25 25 cm (25 plants per square metre) (as shown in Figure 2). With a spacing of 20 10 centimetres (equivalent to 150 plants per square metre), three seedlings were planted in each hill of the SMP field after the nursery had been prepared for a period of 25 days.

Fig 1a: Field preparation

Fig 1b: Nursery after 7 days

Fig 2 a & b. Transplanting of rice seedling

Irrigation management

A ponded layer of five to eight centimetres of water depth was maintained throughout the vegetative stage by continuously flooding and watering the fields on alternate days. This was accomplished by the application of scientific management methodologies. The first irrigation in SRI plots was applied five days after the transplanting process in order to maintain a wet field without ponding. The second irrigation was done nine days later with a ponding depth of five centimetres. Following that, the alternating wetting and drying (AWD) strategy of irrigation was utilised, with irrigation water being provided ten days after the water that had been ponded had disappeared. In order to determine the amount of water and moisture present in the field, a perforated pipe of 40 centimetres in length and 15 centimetres in diameter is planted in the field at a depth of 20 centimetres from the surface of the soil (Fig. 3). When the water level within the tube drops to 15 centimetres below the ground level, the irrigation is administered. The normal scale is used to measure the water level inside the tube. In accordance with the suggestion made by ICAR, the water application of SMP was carried out.

Fig 3. installed perforated pipe for measurement of field water level

Data accusation and analysis

During the course of the experiment, a variety of factors, including initial soil qualities, physiological parameters of rice, and yield parameters, were recorded. The initial soil qualities, which include texture, bulk density, pH, and organic matter, as well as the various physiological parameters of rice, such as plant height, number of leaves, and number of tillering per plant and per m2, were observed from each plot. Also included are the yield characteristics, which include the number of hills or plants, the number of panicles or hills, the number of spikelets per panicle, the weight of one thousand grains (g), the grain yield (t/ha), the straw yield (t/ha), and the harvest index (%). For the purpose of calculating the harvest index (HI), equation 1 is utilised:

$$HI = \frac{Grain\ yield\,(t/ha)}{Biological\ yield\,(t/ha)} \tag{1}$$

Where the biological yield is calculated by adding the grain yield and the straw yield together. The ratio of grain yield (g/ha) to the total amount of water utilised (l/ha) by the rice crop is the formula for calculating water usage efficiency, also known as water productivity (equation 2). Rainfall and water used for irrigation are both included in the total amount of water that is utilised. There is not a substantial quantity of rainfall that takes place in the study region during the seasons when crops are being cultivated.

$$Water\ productivity = \frac{Grain\ yield\,(g/ha)}{Total\ Water\ consumed\,(l/ha)} \tag{2}$$

An analysis of variance (ANOVA) was the statistical approach that was utilised in order to conduct the statistical analysis of the data. To determine whether or not the treatment effect was statistically significant, the F test was utilised. In addition, the least significant difference (LSD) was computed at a 5-percent probability level in order to determine whether or not the difference between the two treatment means was statistically significant.

Results and Discussion

During the beginning of the experiment, the physical qualities of the soil were investigated, and it was discovered that the soil had a sandy loam texture, consisting of sixty percent sand, seventeen percent silt, and twenty-three percent clay. The bulk density, pH, and organic matter of the soil were determined to be 1.60 g/cc, 5.6, and 1.8% correspondingly, whereas the other soil parameters include bulk density.

Crop physiological properties

At each experimental plot, the physiological characteristics of the rice crop were observed. These characteristics included the number of tillerings per plant and per square metre, the height of the plant, and the number of leaves per plant, among other things. At the crucial early-ripening stage, it was found that there were discernible differences in the physiology of the plants between those that were grown using AWD-SRI and those that were grown using traditional cultivation methods with standard management practice (SMP). When compared to SMP plants, AWD-SRI plants had a plant height that was 18% higher and a culm plant height that was 20% higher, respectively (Table 1). The SRI hills had twice as many tillers than the SMP hills, despite the fact that there was only a little variation in the number of tillers divided by the total area. The fact that the average tiller perimeter was 35 percent greater in AWD-SRI plants than it was in SMP plants is demonstrated by the findings presented in Table 1. The findings of the study indicate that the total number of leaves per unit area and hill was much greater in AWD-SRI plants than it was in SMP plants while the plants were in the blooming stage (Table 2). When compared to SMP plants, the AWD-SRI plants had more than twice as many leaves per hill as the SMP plants. When compared to the SMP treatments, it was also observed that the AWDSRI treatments had leaves that were 30.5% longer and 31.2 percent broader than the SMP treatments. In a similar vein, the average width and length of flag leaves in AWD-SRI plants were much bigger than those of SMP plants. AWD-SRI plants have a leaf area index (LAI) that is significantly higher than that of SMP plants due to the fact that they have a greater number of leaves that are larger (Table 2).

Crop growth rate (CGR)

During the vegetative stage of the rice crop that was produced under AWD-SRI and SMP treatments, it was collected for measurement. Up to sixty days after germination, the crop growth rate in the SMP plants was higher than the crop growth rate in the AWD-SRI plants. After that point, the CGR in the SMP plants began to decrease. Because there were no restrictions placed on the tillering process, the CGR of the SRI crop grew consistently throughout the vegetative stage of development.

Yield parameter estimation

While the SMP treatments had 6.2 panicles per hill and 330.2 panicles per square metre, the AWD-SRI treatments had a much greater average number of panicles per hill (12.3 per hill) and per square metre (410.5 per square metre) (Table 3). When comparing the SMP (17.5 cm) treatments to the AWD-SRI treatments, it was discovered that the average length of panicles is substantially longer in the AWD-SRI treatments (20.2 cm). The level of significance for this comparison was determined to be $p < 0.05$. The considerable improvement in yield components that came from the implementation of AWD-SRI management led to a grain yield that was 25.58 percent higher than that of SMP management practices. During the course of the trial, it was discovered that the grain yield was 5.4 t/ha for the AWD-SRI management technique and 4.3 t/ha for the SMP management approach, respectively (Table 4 and Fig. 4). It was claimed in the paper that Singh and Paikra (2014) that the yield of transplanted rice was 5.5 t/ha for the Chhattisgarh area. This result is comparable to the one that we achieved. On the other hand, the present study found that the SMP management approach resulted in a greater straw yield than the AWD-SRI management method.

Table 1. The effects of different management techniques on the height and tiller of rice plants.

Management practices	Plant height(cm)	Culm height(cm)	Averaged llernumber(/hill)	Tiller number(/m2)
AWD-SRI	122.5	83.0	17.2	430.1
SMP	102.3	65.2	10.2	421.2
LSD.05	7.8	3.9	2.9	NS

Table 2. On the leaves of rice plants, the effects of various management interventions

Management practices	Number of leaf (/hill)	Number of leaf (/m2)	Average length of leaf (cm)	Average width of leaf (cm)	Average length of flag leaf (cm)	leaf area index (LAI)
AWD-SRI	75.0	1921.0	1.65	35.52	1.92	3.55
SMP	33.0	1706.0	1.33	25.72	1.52	2.60
$LSD_{.05}$	15.2	220.1	0.25	4.33	0.45	0.26

Table 3. The impact of various management techniques on the panicles of rice cultivators

Management practices	Average particle number/hill	Panicles (/m2)	Average length of panicle(cm)	Spikelet number/panicle	1000 weight(g)	grain
AWD-SRI	12.3	410.5	20.2	142.5	23.5	
SMP	6.2	330.2	17.5	101.3	22.2	

LSD.05	3.3	56.5	2.5	10.3	0.3	

Table 4. Rice yield and the effects of different management techniques

Management practices	Grain yield(t/ha)	Straw yield(t/ha)	Biological yield (t/ha)	Harvest Index
AWD-SRI	5.4	6.53	11.93	0.63
SMP	4.3	8.27	12.57	0.52
LSD.05	0.22	1.11	1.02	0.05

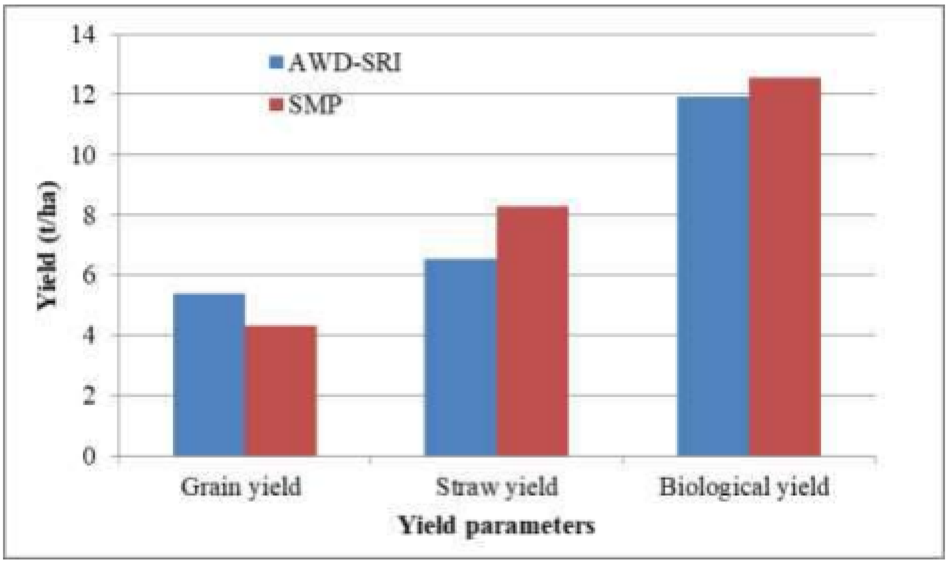

Fig 4. Both management approaches result in different yield characteristics for the rice yield.

Table 5. Observations about the impact of rice management on water conservation and productivity

Management	Irrigation applied	Total water consumed	Water productivity	Water saving with AWD-
practices	(×104l/ha)	(×104l/ha)	(g/l)	SRI(%)
AWD-SRI	1065.5	1065.5	0.51	27.23
SMP	1355.7	1355.5	0.32	-

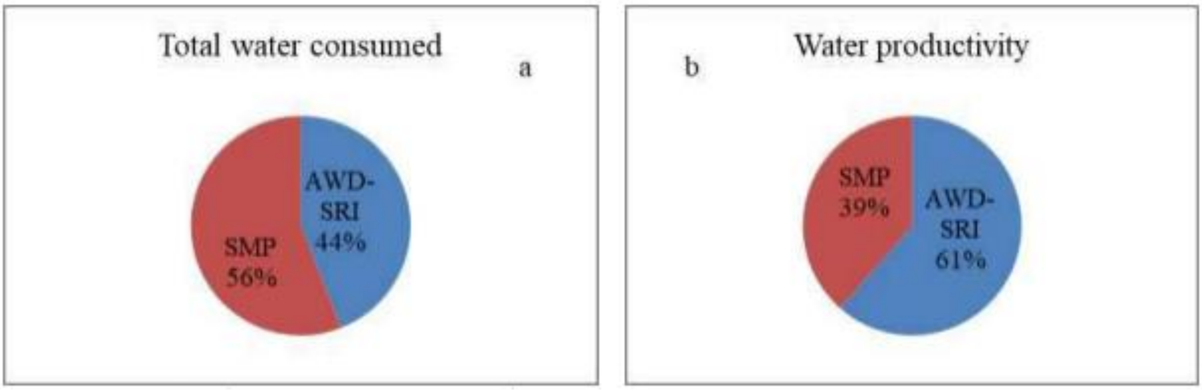

Fig 4 a). total amount of water used, as well as water productivity measured using the AWD-SRI and SMP methods

Water productivity and conservation

During the growth season of the crop, the research region saw a marginal rainfall of less than two millimetres, which does not have any major impact on the crop's water need. Additionally, irrigation water is utilised in order to fulfil the rice crop's water requirements, as shown in Table 5 and Figure 5a here. On the other hand, it was discovered that the water productivity of AWD-SRI was much greater (0.51 g/l) than that of the SMP management technique (0.32 g/l). Furthermore, it was revealed that AWD-SRI conserved 27.23% of water in comparison to the flooded SMP method for the rice crop (Table 5 and Fig-5b). The reduction in the application of surplus water, seepage, and percolation loss might be the cause of this improvement in water conservation. The water productivity and water saving that were seen using ADW-SRI were comparable to those that were reported in prior studies conducted in Eastern India (Orissa) (Thakur et al., 2011). Rejesus et al. (2011) and Carrijo et al. (2017) conducted a research that was quite similar to this one, and it found that employing AWD for the rice crop resulted in a decrease of irrigation hours by 38% and a saving of water.

Conclusion

This research investigates the relative resource efficiency of rice and vegetable farming in the Durg District. It focusses on important aspects such as the amount of water used, the amount of fertiliser applied, the amount of labour that is produced, and the economic returns that are generated. Based on the data, it can be concluded that vegetable farming is substantially more resource-efficient than rice production. This is especially true when considering the efficiency with which water is used, the reduced dependence on inputs, and the better profitability per hectare. Rice, being a staple grain, continues to dominate the agricultural landscape despite the fact that it increases the amount of resources required and has a greater impact on the environment. The use of water-efficient irrigation systems, the promotion of balanced fertiliser application, and the encouragement of crop variety are all urgently required in order to guarantee the implementation of sustainable agricultural practices in the Durg District. It is possible for policy interventions to improve both production and environmental conservation. Some examples of such interventions are subsidies for drip irrigation, incentives for organic farming, and education programs for farmers on sustainable methods. In order to achieve a balance between food security and sustainability, it is possible to make a strategic move towards integrated farming systems. These systems involve the growing of rice in conjunction with resource-efficient crops such as vegetables. Through the use of new agricultural practices and the optimisation of resource allocation, farmers in the Durg District have the capacity to raise their standard of living while simultaneously guaranteeing the long-term sustainability of the environment.

References

[1] Belder P, Bouman BAM, Cabangon R (2004). Effect of water-saving irrigation on rice yield and water use in typical lowland conditions in Asia. Agric Water Manag. 65: 193–210.

[2] Bouman BAM A (2007). conceptual framework for the improvement of crop water productivity at different spatial scales. Agric Syst, 93: 43–60.

[3] Budianto MB, Supriadi A, Hidayat S, Salehudin S (2021). Model Irigasi Hemat Air Perpaduan System Of Rice Intensification (Sri) Dengan Alternate Wetting And Drying (Awd) Pada Padi Sawah. Prosiding SAINTEK LPPM Universitas Mataram, (E-ISSN: 2774-8057), 3.

[4] Carrijo DR, Lundy M E, Bruce A, Linquist B A (2017). Rice yields and water use under alternate wetting and drying irrigation: A meta-analysis. Field Crops Res. 203, 173-180.

[5] FAO, (2016) FAOSTAT Data (available at: http://faostat3. fao.org/browse/FB/CC/E[Accessed on 03 March 2021]).

[6] Lampayan RM, Rejesus RM, Singleton GR, Bouman BAM (2015). Adoption andeconomics of alternate wetting and drying water management for irrigated lowland rice. Field Crops Res, 170: 95–108.

[7] Laulanie´ H (1993). Le syste`me de riziculture intensive malgache. Tropicultura, 11: 110–114.

[8] Mekonnen MM, Hoekstra AY (2016). Four billion people facing severe water scarcity. Sci Adv. 12;2(2): e1500323. doi: 10.1126/sciadv.1500323.

[9] Meyer R (2009). Agricultural technologies for developing countries. European Parliament Brussels.

[10] Navarathna C, Pathiratne S, de Silva DSM, Rinklebe J, Mohan D, Mlsna T (2021). Intrusion of heavy metals/metalloids into rice (Oryza sativa L.) in relation to their status in two different agricultural management systems in Sri Lanka. Groundwater for Sustainable Development, 100619.

[11] Singh M, Paikra PR (2014). Bio-efficacy of post-emergence herbicides in transplanted rice of chhattisgarh plains. The Bio, 9(3): 973-976

[12] Sato S, Uphof N (2007). A review of on-farm evaluations of system of rice intensifcation methods in Eastern Indonesia. CAB Rev: Perspect in Agric, Vet Sci, Nut Natl Res, 2: 1–12 https://doi.org/10.1079/PAVSNNR20072054

[13] Tuong TP, Bouman BAM (2003). Rice production in waterscarce environments. In: Proceedings of the Water Productivity Workshop, International Water Management Institute, Colombo, Sri Lanka, 12–14, 2001.

[14] USDA, World Rice Production, Consumption, and Stocks (2016). United States Department of Agriculture. Foreign Agricultural Service (Available at: http://apps.fas.usda.gov/psdonline/psdHome.aspx [Accessed on 04 May 2021]).

[15] Weerakoon S, Somaratne S (2021). Genetic diversity of weedy rice (Oryza sativa f. spontanea) populations in Sri Lanka: An application of Self Organizing Map (SOM). Asian Journal of Agriculture, 5(1).